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Amendments to the Claims

The following listing of claims will replace all prior versions, and listings, of claims in this patent application:

1. (previously presented) An apparatus for precisely and reliably assembling a critical joint, comprising:

a thread-forming fastener including a head for engagement by a tool for applying a torque to the fastener, and a body portion extending from the head and including thread-forming portions; and

an ultrasonic transducer coupled with the fastener, for making precise and reliable ultrasonic load measurements in the fastener.

2. (previously presented) The apparatus of claim 1 wherein the ultrasonic transducer is coupled with the head of the fastener.

3. (previously presented) The apparatus of claim 1 wherein the ultrasonic transducer is permanently attached to the fastener.

4. (previously presented) The apparatus of claim 3 wherein the ultrasonic transducer is comprised of a piezoelectric polymer film permanently attached to the head of the fastener.

5. (previously presented) The apparatus of claim 3 wherein the ultrasonic transducer is comprised of an oriented piezoelectric thin film, vapor deposited directly on the head of the fastener.

6. (previously presented) The apparatus of claim 3 wherein the ultrasonic transducer is chemically grafted on the head of the fastener.

7. (previously presented) The apparatus of claim 1 wherein the ultrasonic transducer is temporarily attached to the fastener.

8. (previously presented) The apparatus of claim 1 wherein the ultrasonic transducer further includes an information storage medium applied to the ultrasonic transducer, wherein the information storage medium includes markings corresponding to data associated with the fastener.

9. (previously presented) The apparatus of claim 8 wherein the information storage medium is a bar code applied to the ultrasonic transducer.

10. (previously presented) A method of making a load indicating, thread-forming fastener for precisely and reliably assembling a critical joint, comprising the steps of:

providing a fastener having a first end including a surface for receiving an ultrasonic transducer, for making ultrasonic load measurements in the fastener, a shank extending from the first end and including thread-forming portions for tapping a hole, and a second end, opposite the first end and including a surface for reflecting an ultrasonic wave back to the first end; and

attaching an ultrasonic transducer for making precise and reliable ultrasonic load measurements in the fastener to the first end of the fastener.

11. (previously presented) The method of claim 10 which further includes the step of attaching the ultrasonic transducer to a head associated with the first end of the thread forming fastener, for engagement by a tool for applying a torque to the fastener.

12. (previously presented) The method of claim 10 which further includes the step of permanently attaching the ultrasonic transducer to the fastener.

13. (previously presented) The method of claim 12 which further includes the step of permanently attaching an ultrasonic transducer comprised of a piezoelectric polymer film to the first end of the fastener.

14. (previously presented) The method of claim 12 which further includes the step of vapor depositing an ultrasonic transducer comprised of an oriented piezoelectric thin film directly onto the first end of the fastener.

15. (previously presented) The method of claim 12 which further includes the step of chemically grafting an ultrasonic transducer onto the first end of the fastener.

16. (previously presented) The method of claim 10 which further includes the step of temporarily attaching the ultrasonic transducer to the fastener.

17. (previously presented) The method of claim 10 which further includes the step of applying an information storage medium to the ultrasonic transducer, wherein the information storage medium includes markings corresponding to data associated with the fastener.

18. (previously presented) The method of claim 17 which further includes the step of applying a bar code to the ultrasonic transducer.

19. (withdrawn) A method of measuring a load in a fastener, comprising the steps of:  
providing a thread-forming fastener including a head

for engagement by a tool for applying a torque to the fastener, and a body portion extending from the head and including thread-forming portions;

coupling an ultrasonic transducer with the fastener, for making ultrasonic load measurements in the fastener;

electrically connecting an apparatus to the ultrasonic transducer for supplying signals to the ultrasonic transducer and for receiving signals from the ultrasonic transducer;

monitoring the signals received from the ultrasonic transducer, providing an accurate measurement indicative of the load in the fastener; and

adjusting the measurement indicative of the load to compensate for effects of heating of the fastener resulting from forming a thread in a mating component during installation.

20. (withdrawn) The method of claim 19 which further includes the step of imparting torque to the fastener and removing torque from the fastener in response to the measurement of the load in the fastener.

21. (withdrawn) The method of claim 19 which further includes the step of determining a zero-load ultrasonic measurement, using the measurement indicative of the load in the fastener.

22. (withdrawn) The method of claim 21 which further

includes the step of measuring a torque in conjunction with the measurement indicative of the load in the fastener to determine the zero-load ultrasonic measurement.

23. (withdrawn) The method of claim 21 which further includes the step of measuring an angle of rotation of the fastener in conjunction with the measurement indicative of the load in the fastener to determine the zero-load ultrasonic measurement.

24. (withdrawn) The method of claim 21 which further includes the step of measuring time in conjunction with the measurement indicative of the load in the fastener to determine the zero-load ultrasonic measurement.

25. (withdrawn) The method of claim 21 which further includes the step of taking measurements for determining the zero-load ultrasonic measurement prior to a load-inducing stage of the installation.

26. (withdrawn) The method of claim 21 which further includes the step of taking measurements for determining the zero-load ultrasonic measurement during a load-inducing stage of the installation.

27. (withdrawn) The method of claim 19 which further

includes the step of placing markings on the ultrasonic transducer corresponding to data associated with the fastener.

28. (withdrawn) The method of claim 27 which further includes the step of marking a bar code on the ultrasonic transducer.

29. (withdrawn) A method of measuring a load in a fastener, comprising the steps of:

providing a thread-locking fastener assembly including a bolt having a head for engagement by a tool for applying a torque to the fastener assembly and a body portion extending from the head, and a nut for cooperating with the body portion of the bolt, wherein portions of the fastener assembly include resistance-inducing threads;

coupling an ultrasonic transducer with the bolt, for making ultrasonic load measurements in the fastener assembly;

electrically connecting an apparatus to the ultrasonic transducer for supplying signals to the ultrasonic transducer and for receiving signals from the ultrasonic transducer;

monitoring the signals received from the ultrasonic transducer, providing an accurate measurement indicative of the load in the fastener assembly; and

adjusting the measurement indicative of the load to compensate for effects of heating of the fastener assembly resulting from prevailing torque associated with the

thread-locking fastener assembly.

30. (withdrawn) The method of claim 29 which further includes the step of imparting torque to the bolt and removing torque from the bolt in response to the measurement of the load in the fastener assembly.

31. (withdrawn) The method of claim 29 which further includes the step of determining a zero-load ultrasonic measurement, using the measurement indicative of the load in the fastener assembly.

32. (withdrawn) The method of claim 31 which further includes the step of measuring a torque in conjunction with the measurement indicative of the load in the fastener assembly to determine the zero-load ultrasonic measurement.

33. (withdrawn) The method of claim 31 which further includes the step of measuring an angle of rotation of the fastener in conjunction with the measurement indicative of the load in the fastener assembly to determine the zero-load ultrasonic measurement.

34. (withdrawn) The method of claim 31 which further includes the step of measuring time in conjunction with the measurement indicative of the load in the fastener assembly



to determine the zero-load ultrasonic measurement.

35. (withdrawn) The method of claim 31 which further includes the step of taking measurements for determining the zero-load ultrasonic measurement prior to inducing the load in the fastener assembly.

36. (withdrawn) The method of claim 31 which further includes the step of taking measurements for determining the zero-load ultrasonic measurement while inducing the load in the fastener assembly.

37. (withdrawn) The method of claim 29 which further includes the step of placing markings on the ultrasonic transducer corresponding to data associated with the fastener assembly.

38. (withdrawn) The method of claim 37 which further includes the step of marking a bar code on the ultrasonic transducer.

39. (new) The apparatus of claim 1, in combination with a load measurement apparatus for making ultrasonic load measurements in the fastener, wherein the load measurement apparatus is electrically connected to the ultrasonic transducer for supplying signals to the ultrasonic transducer and for receiving signals from the ultrasonic transducer, wherein the

signals received from the ultrasonic transducer are monitored to provide an accurate measurement indicative of the load in the fastener, and wherein the measurement indicative of the load is adjusted to compensate for effects of heating of the fastener resulting from forming a thread in a mating component during installation.

40. (new) The apparatus of claim 39 wherein the load measurement apparatus is coupled with a tool for engaging the head of the fastener, and wherein the tool imparts torque to the fastener and removes torque from the fastener responsive to the measurement of the load in the fastener.

41. (new) The apparatus of claim 39 wherein the load measurement apparatus determines a zero-load ultrasonic measurement in the fastener using the measurement indicative of the load in the fastener.

42. (new) The apparatus of claim 41 wherein the load measurement apparatus determines the zero-load ultrasonic measurement prior to a load-inducing stage of the installation.

43. (new) The apparatus of claim 41 wherein the load measurement apparatus determines the zero-load ultrasonic measurement during a load-inducing stage of the installation.

44. (new) The apparatus of claim 39 which further includes markings placed on the ultrasonic transducer which correspond to data associated with the fastener.

45. (new) The apparatus of claim 44 wherein the markings are a bar code placed on the ultrasonic transducer.